Biodiesel – Key Trends and Innovative Developments

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Introduction

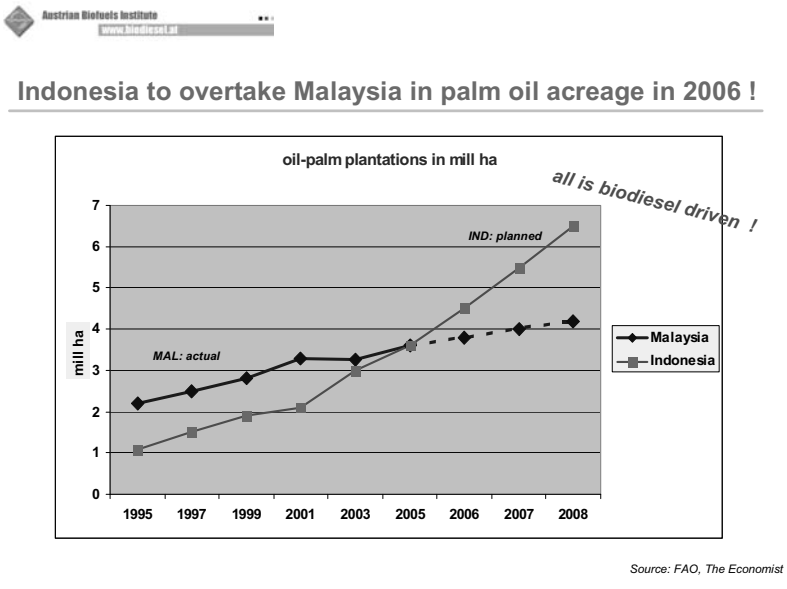
Historically the development of biodiesel was started in small lab scale pilot plants in 1987 at the Federal Institute for Agricultural Engineering in Wieselburg in Austria and with the establishing of the first industrial scale biodiesel production plant in 1992 at Aschach in Austria, but it took quite some time until biodiesel became accepted as a technically reliable fuel for the modern diesel engine.

One key element in market acceptance was the development of a biodiesel standard ON C 1190 in Austria followed by the European standard EN 14214 as a basis for quality assurance, which led to acceptance of biodiesel as a reliable fuel by the diesel engine and fuel injection equipment industry.

Present production development

Supported by adequate legislation within the European Union biodiesel was able to gain broader acceptance and market share. Triggered by the promising production and usage development in the European Union as well as by rising crude oil prices other countries on continents all over the world discovered these new business opportunities and started to develop a national biodiesel industry as well.

This development has however reached today an unexpected strong accelerating momentum all over the world, specifically in e.g. Southeast Asia (Malaysia, Indonesia, Singapore, China), in North and South America (Brazil, Argentina, USA,) and Southeast Europe (Romania, Serbia), where challenging expansion plans can be observed: e.g. by 2010 Malaysia wants to capture 10 % of the global biodiesel market, China intends to reach a 10 % market share by 2010, Indonesia is expanding its oil palm plantation from 3 mill in 2003 to nearly 7 mill ha by 2008:



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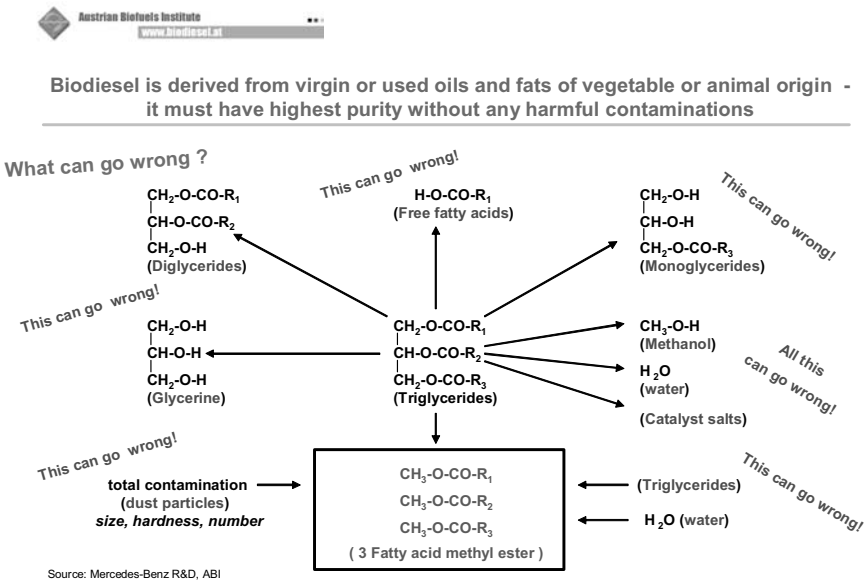
For a solid and sustainable development of a national biodiesel industry a few key criteria have to be fulfilled, which are:

- Producing high quality biodiesel according to well defined standard specifications.
- Assure supply of suitable and low cost feedstock from a variety of food as well as non-food oilseed plants and sources contributing to the production of high quality biodiesel.
- Select and use a highly efficient and flexible biodiesel production process technology.
- Select a site for biodiesel production with low logistic cost and strong synergistic factors.
- Identify profitable markets with secured take-off conditions.
- Use all biodiesel information, which is readily available today.
- Secure industrial profitability by supportive national legal framework.

Investing into a biodiesel production plant and running such an industry according to above mentioned criteria will lead to a solid and sustainable profit and a secured competitive position.

1. Quality assurance

One has to be aware that during the process of converting a vegetable oil into biodiesel many unwanted reactions and chemical substances can develop as shown below:



As the modern, highly fuel efficient diesel engine has to provide highest performance, while working at challenging low emission levels for e.g. particulate matter (PM), hydrocarbons (HC) and NOx (Nitrous oxide) as demanded by health supporting legislation, the quality for a diesel fuel – regardless whether of fossil or bio origin – must have highest quality, which is defined in Europe by the biodiesel fuel standard EN 14214 in 30 different criteria and limits.

It goes without saying that a quality assurance laboratory at a biodiesel production plant must be well equipped and the staff well trained.

2. Feedstock suitability, supply and multifeedstock-flexibility

Presently rapeseed oil is the leading feedstock in volume with a high market share within the European Union, while palm oil is the feedstock of choice in Malaysia and Indonesia and soy oil in the traditionally soy growing countries like Brazil and the USA. In a few countries also low cost waste oils from restaurants or animal fats from slaughterhouses are used to a limited extent.

It has to be observed however that at the end of the pipe high quality biodiesel according to the EN 14214 standard has to be produced regardless of the kind of feedstock used.

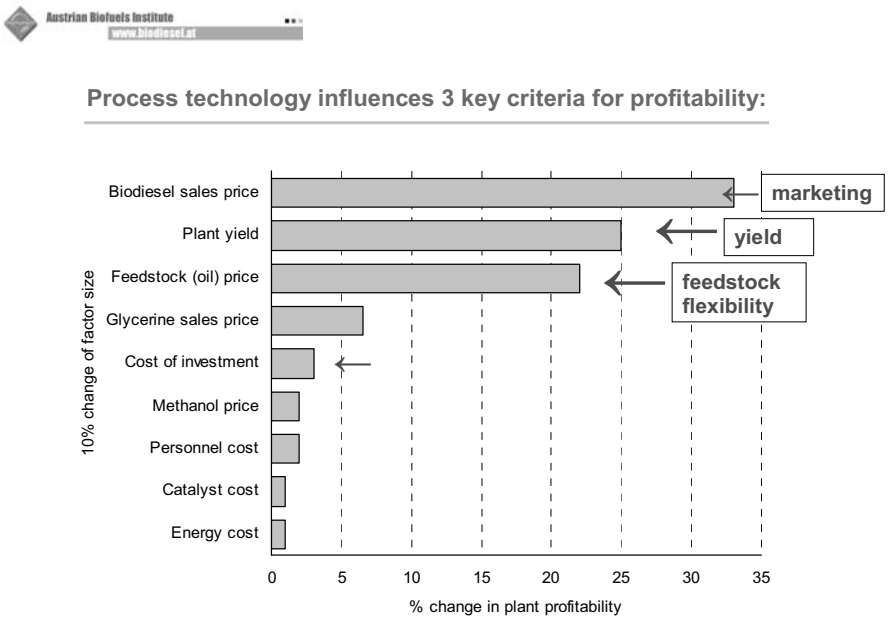
There are also many non-food oilseed crops available like the physic nut (*Jatropha curcas*), which produces a highly suitable oil and which is looking very promising as a crop for planting in semi-arid climatic zones with marginal soils but will need time for further breeding and improvements concerning yield.

Coconut oil (e.g. *Cocos nucifera* in African countries, *Acrocomia totai* in Paraguay) can become as well an interesting supply source as biodiesel produced from such oil exhibits smooth combustion behaviour, very high oxidation stability because of the high level of saturation but with slightly lower energy content than the standard food oils.

From a commercial standpoint one should prefer those process technologies and plant designs, which are able to process a number of different oils and fats in a flexible way, thus being able to take advantage of the cheapest but suitable oil on the market at a specific point of time.

3. Select and use a highly efficient and flexible biodiesel production process technology

As the basic chemical process working at normal pressure and ambient temperature appears to be quite simple, which can be easily reproduced in any chemical laboratory, one can observe the emergence of quite a number of "inventors" of a seemingly new biodiesel process. Usually those "technologies" have weaknesses in reaching the required quality and in reaching required high yield levels, which should not go below 99% of all available triglycerides and free fatty acids in an oil being turned into FAME (Fatty-Acid-Methyl-Ester) or biodiesel.



Above graph shows the sensitivity of a number of factors, which have an influence on profitability. While marketing biodiesel is most important (a 10% biodiesel sales price discount results in a 33% drop in profitability), yield as factor of process efficiency is second in importance as a 10% drop in yield results in a 25% drop in profitability, which is mostly disregarded by so called hobby inventors.

Flexibility in choosing, storing and processing a large variety of different oils and fats and thus being always able to purchase from the cheapest source is ranked third in importance.

The following process technology suppliers as well as engineering companies can be recommended as they all meet the above mentioned criteria and offer proven technologies:

- AT-Agrartechnik (Germany),
- Axens (France),
- BDI (Austria),
- Christof Group (Austria),
- Desmet Ballestra (Netherlands/Italy),
- Energea (Austria),
- Lurgi (Germany),
- Westfalia, using the Connemann process (Germany).

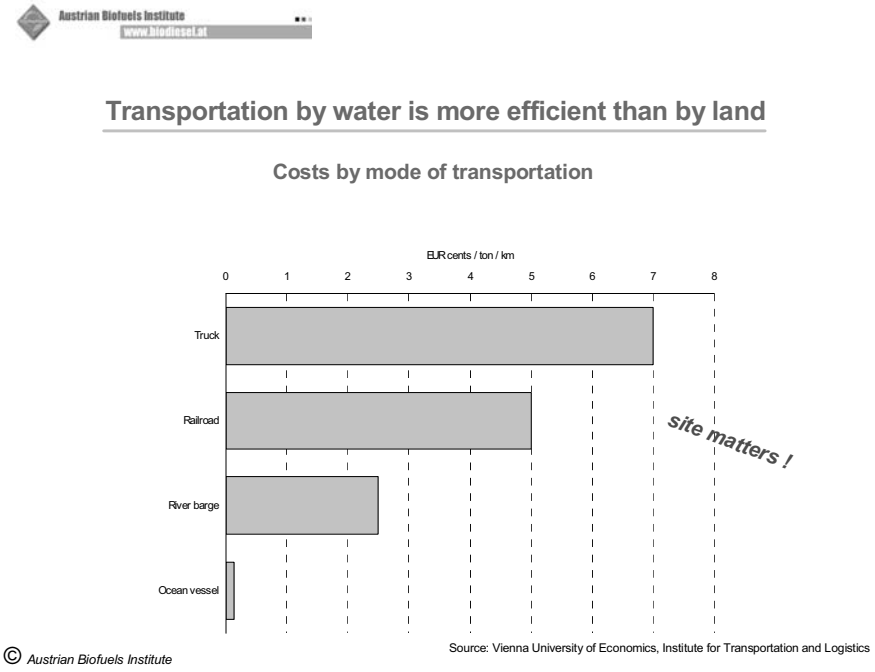
During the workshop the recently completed study "Biodiesel Production: Technologies and European Providers" was distributed on CD-ROM (free of charge), on which the above mentioned process technologies are described in detail as orientation for investors into the biodiesel industry.

This study was supported by the International Energy Agency (Bioenergy Agreement – Task 39) and completed by the Austrian Biofuels Institute in cooperation with BLT-Wieselburg and the University of Graz in 2007.

4. Site selection

One additional key factor for profitability in the Biodiesel business is logistics, i.e. transport cost of supplied feedstock from vegetable oil or oilseed suppliers and of Biodiesel to consumer markets. Those products are usually traded worldwide in very large volumes at rather low feedstock price levels.

It is therefore not a surprise that deep sea harbour sites have a clear cost advantage both for purchasing oilseeds or vegetable oils in ocean vessel type volumes on the world markets and for selling Biodiesel in large volumes for blending to oil refineries within those harbours (e.g. Rotterdam) transported there ideally by pipeline.



5. Identify profitable markets with secured take-off conditions

Market conditions may be influenced by national legislation in most of the countries involved, e.g. the Directive on Biofuels of the European Commission requires minimum market shares to be reached by a certain point of time, which is:

- 2 % obligatory market share of biofuels (biodiesel and/or bioethanol) by the year 2005, and
- 5,75 % obligatory market share of biofuels by the year 2010,
- and with a so far not committing vision of 10% market share by the year 2020.

As not all biodiesel is going to be produced within the European Union one can expect that quite a sizeable import business is going to be developed, which can be seen as a business opportunity of countries strong in feedstock production and supply e.g. Malaysia.

6. Use all biodiesel information, which is readily available today

In contrary to the very beginning of biodiesel in 1988 there is plenty of well founded information available today, which in most cases can be obtained free of charge. It is therefore recommended to use all those information as much as possible before reinventing the wheel again.

Recommended websites and printed information:

- European Biodiesel Board - http://www.ebb-eu.org
- Union zur Förderung von Öl- und Proteinpflanzen (Union for the Promotion of Oilseed and Protein Plants) / Germany - http://www.ufop.de/english_news.php
- National Biodiesel Board / USA - http://www.nbb.org

The „Handbook of Analytical Methods for Fatty-Acid-Methyl-Esters used as Diesel Fuel Substitutes" as published by the Research Institute for Chemistry and Technology of Petroleum Products at the University of Technology in Vienna. (Approx. 30 handbooks were distributed at the workshop by the Austrian Biofuels Institute free of charge.)

7. Secure industrial profitability by supportive national legal framework

Generally it needs a well defined and lasting legal framework in order to assure profitable production, distribution and usage of liquid biofuels in the transport sector. Such legal tools can contain e.g.

- financial support for production of feedstock (specific food as well as non-food oilseeds),
- fuel tax exemption for final biodiesel usage at the fuel pump,
- legislation for minimum market shares for liquid biofuels in the transport fuel market. This model is practiced with success in the European Union with the following targets:
    - 2 % market share of liquid biofuels by the year 2005,
    - 5,75 % market share of liquid biofuels by the year 2010,
    - 10 % market share of liquid biofuels by the year 2020 (so far as indicative target).
    - This model leaves many options open to the individual country, which can choose the type of biofuel produced within the country or which can opt also for achieving theses goal by imports (e.g. Bioethanol from Brazil).
    - It can as well select specific market segments for intensified use (e.g. public bus traffic and taxis in cities).

It has to be mentioned however that the trade of liquid biofuels has reached an international dimension as both suitable feedstock (e.g. palm oil from Malaysia, soy oil from the USA) as well as biodiesel (e.g. B-99 via USA to Europe) is already traded in large volumes over the oceans of this world.

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